

# 6

## Investment Decisions

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### Learning Objectives

After studying this chapter you will be able to:

- Define “capital budgeting” and explain the purpose and process of Capital Budgeting for any business.
- Explain the importance of cash flows in capital budgeting decisions and try to explain the basic principles for measuring the same.
- Evaluate investment projects using various capital budgeting techniques like PB (Pay Back), NPV (Net Present Value), PI (Profitability Index), IRR (Internal Rate of Return), MIRR (Modified Internal Rate of Return) and ARR (Accounting Rate of Return).
- Understand the advantages and disadvantages of the above mentioned techniques.

### Overview

In this chapter, you will study the capital budgeting decisions, which are essential, fundamental and critical business decisions of a firm. Since these decisions need huge amount of capital outlay, are surrounded by great number of uncertainties and have long-term implications, therefore, there is an underlying need for thoughtful and correct decision-making. Capital budgeting decision-making is a difficult and complicated exercise for the management. These decisions require an overall assessment of future events which are quite uncertain. The basic concept underlining these decisions is investing in assets and projects which provide a greater return as compared to the minimum acceptable rate. In this chapter you will not only study the importance of investment decisions but will also learn about the different tools and techniques which help in arriving at a sound financial decision.

### 6.1 Capital Budgeting Definition

Capital budgeting is the process of evaluating and selecting long-term investments that are in line with the goal of investors' wealth maximization.

When a business makes a capital investment (assets such as equipment, building, land etc.) it incurs a cash outlay in the expectation of future benefits. The expected benefits generally extend beyond one year in the future. Out of different investment proposals available to a business, it has to choose a proposal that provides the best return and the return equals to, or greater than, that required by the investors.

In simple terms, Capital Budgeting involves:-

- Evaluating investment project proposals that are strategic to business overall objectives;
- Estimating and evaluating post-tax incremental cash flows for each of the investment proposals; and
- Selection an investment proposal that maximizes the return to the investors.

However, Capital Budgeting excludes certain investment decisions, wherein, the benefits of investment proposals cannot be directly quantified. For example, management may be considering a proposal to build a recreation room for employees. The decision in this case will be based on qualitative factors, such as management – employee relations, with less consideration on direct financial returns.

However, most investment proposals considered by management will require quantitative estimates of the benefits to be derived from accepting the project. A bad decision can be detrimental to the value of the organisation over a long period of time.

### 6.2 Purpose of Capital Budgeting

The capital budgeting decisions are important, crucial and critical business decisions due to following reasons:

- (i) **Substantial expenditure:** Capital budgeting decisions involves the investment of substantial amount of funds. It is therefore necessary for a firm to make such decisions after a thoughtful consideration so as to result in the profitable use of its scarce resources.  
  
The hasty and incorrect decisions would not only result into huge losses but may also account for the failure of the firm.
- (ii) **Long time period:** The capital budgeting decision has its effect over a long period of time. These decisions not only affect the future benefits and costs of the firm but also influence the rate and direction of growth of the firm.
- (iii) **Irreversibility:** Most of the investment decisions are irreversible. Once they are taken, the firm may not be in a position to reverse them back. This is because, as it is difficult to find a buyer for the second-hand capital items.
- (iv) **Complex decision:** The capital investment decision involves an assessment of future events, which in fact is difficult to predict. Further it is quite difficult to estimate in quantitative terms all the benefits or the costs relating to a particular investment decision.

### 6.3 Capital Budgeting Process

The extent to which the capital budgeting process needs to be formalised and systematic procedures established depends on the size of the organisation; number of projects to be considered; direct financial benefit of each project considered by itself; the composition of the firm's existing assets and management's desire to change that composition; timing of expenditures associated with the projects that are finally accepted.

- (i) **Planning:** The capital budgeting process begins with the identification of potential investment opportunities. The opportunity then enters the planning phase when the potential effect on the firm's fortunes is assessed and the ability of the management of the firm to exploit the opportunity is determined. Opportunities having little merit are rejected and promising opportunities are advanced in the form of a proposal to enter the evaluation phase.
- (ii) **Evaluation:** This phase involves the determination of proposal and its investments, inflows and outflows. Investment appraisal techniques, ranging from the simple payback method and accounting rate of return to the more sophisticated discounted cash flow techniques, are used to appraise the proposals. The technique selected should be the one that enables the manager to make the best decision in the light of prevailing circumstances.
- (iii) **Selection:** Considering the returns and risks associated with the individual projects as well as the cost of capital to the organisation, the organisation will choose among projects so as to maximise shareholders' wealth.
- (iv) **Implementation:** When the final selection has been made, the firm must acquire the necessary funds, purchase the assets, and begin the implementation of the project.
- (v) **Control:** The progress of the project is monitored with the aid of feedback reports. These reports will include capital expenditure progress reports, performance reports comparing actual performance against plans set and post completion audits.
- (vi) **Review:** When a project terminates, or even before, the organisation should review the entire project to explain its success or failure. This phase may have implication for firms planning and evaluation procedures. Further, the review may produce ideas for new proposals to be undertaken in the future.

### 6.4 Types of Capital Investment Decisions

There are many ways to classify the capital budgeting decision. Generally capital investment decisions are classified in two ways. One way is to classify them on the basis of firm's existence. Another way is to classify them on the basis of decision situation.

**6.4.1 On the basis of firm's existence:** The capital budgeting decisions are taken by both newly incorporated firms as well as by existing firms. The new firms may be required to take decision in respect of selection of a plant to be installed. The existing firm may be

required to take decisions to meet the requirement of new environment or to face the challenges of competition. These decisions may be classified as follows:

- (i) **Replacement and Modernisation decisions:** The replacement and modernisation decisions aim at to improve operating efficiency and to reduce cost. Generally all types of plant and machinery require replacement either because of the economic life of the plant or machinery is over or because it has become technologically outdated. The former decision is known as replacement decisions and latter is known as modernisation decisions. Both replacement and modernisation decisions are called *cost reduction decisions*.
- (ii) **Expansion decisions:** Existing successful firms may experience growth in demand of their product line. If such firms experience shortage or delay in the delivery of their products due to inadequate production facilities, they may consider proposal to add capacity to existing product line.
- (iii) **Diversification decisions:** These decisions require evaluation of proposals to diversify into new product lines, new markets etc. for reducing the risk of failure by dealing in different products or by operating in several markets.

Both expansion and diversification decisions are called *revenue expansion decisions*.

**6.4.2 On the basis of decision situation:** The capital budgeting decisions on the basis of decision situation are classified as follows:

- (i) **Mutually exclusive decisions:** The decisions are said to be mutually exclusive if two or more alternative proposals are such that the acceptance of one proposal will exclude the acceptance of the other alternative proposals. For instance, a firm may be considering proposal to install a semi-automatic or highly automatic machine. If the firm installs a semi-automatic machine it excludes the acceptance of proposal to install highly automatic machine.
- (ii) **Accept-reject decisions:** The accept-reject decisions occur when proposals are independent and do not compete with each other. The firm may accept or reject a proposal on the basis of a minimum return on the required investment. All those proposals which give a higher return than certain desired rate of return are accepted and the rest are rejected.
- (iii) **Contingent decisions:** The contingent decisions are dependable proposals. The investment in one proposal requires investment in one or more other proposals. For example, if a company accepts a proposal to set up a factory in remote area it may have to invest in infrastructure also e.g. building of roads, houses for employees etc.

## 6.5 Project Cash Flows

Capital Budgeting analysis considers only incremental cash flows from an investment likely to result due to acceptance of any project. Therefore, one of the most important tasks in capital budgeting is estimating future cash flows for a project. Though among various techniques one

technique (Accounting Rate of Return, discussed in detail later on) is based on profit. Since timing of cash flow may not match with period of profit normally firms may be more interested in cash flows. For example Profit and Loss Account may show a sale of ₹ 100 crore, but actual cash receipt may be lesser. Similarly, for purchase full payment may not have been made by the company. Further, depreciation is a non-cash item as its outflow of cash takes place in the beginning at the time of purchase of machinery and at the end as scrap sale. Thus, due to this time difference it is better to eliminate decision on the basis of cash flows rather than profit. The final decision we make at the end of the capital budgeting process is no better than the accuracy of our cashflow estimates.

The estimation of costs and benefits are made with the help of inputs provided by marketing, production, engineering, costing, purchase, taxation, and other departments.

The project cash flow stream consists of cash outflows and cash inflows. The costs are denoted as cash outflows whereas the benefits are denoted as cash inflows.

An investment decision implies the choice of an objective, an appraisal technique and the project's life. The objective and technique must be related to definite period of time. The life of the project may be determined by taking into consideration the following factors:

- (i) Technological obsolescence;
- (ii) Physical deterioration; and
- (iii) A decline in demand for the output of the project.

No matter how good a company's maintenance policy, its technological forecasting ability or its demand forecasting ability, uncertainty will always be present because of the difficulty in predicting the duration of a project life.

**Calculating Cash Flows:** Before, we analyze how cash flow is computed in capital budgeting decision following items need consideration:

*(a) Depreciation:* As mentioned earlier depreciation is a non-cash item and itself does not affect the cash flow. However, we must consider tax shield or benefit from depreciation in our analysis. Since this benefit reduces cash outflow for taxes it is considered as cash inflow. To understand how depreciation acts as tax shield let us consider following example:

### Example

X Ltd. is manufacturing electronic motors fitted in the desert coolers. Its annual turnover is ₹ 30 crore and cash expenses to generate this sale are ₹ 25 crore. Suppose if applicable tax rate is 30% and depreciation is ₹ 1.50 crore p.a., then let us see how depreciation shall act as tax shield from the following table showing cash flow under two scenarios one with depreciation and another without depreciation.

	No Depreciation is Charged (₹ Crore)	Depreciation is Charged (₹ Crore)
Total Sales	30.00	30.00
Less: Cost of Goods Sold	25.00	25.00
	5.00	5.00
Less: Depreciation	-	1.50
Profit before tax	5.00	3.50
Tax @ 30%	1.50	1.05
Profit after Tax	3.50	2.45
Add: Depreciation*	-	1.50
Cash Flow	3.50	3.95

\* Being a non cash expenditure depreciation has been added back while calculating the cash flow.

(b) *Opportunity Cost*: Sometimes, managers of a project may overlook some of the cost of the project which are not paid in cash directly i.e. opportunity cost.

This opportunity cost can occur both at the time of initial outlay or during the tenure of the project. For example if a company owns a piece of land acquired 10 years ago for ₹ 1 crore at that time and today it can be sold for ₹ 10 crore. If company uses this piece of land for a project then its sale value i.e. ₹ 10 crore forms the part of initial outlay. The cost of acquisition 10 years ago shall be irrelevant for decision making.

Similarly, alternative cash inflow foregone due to acceptance of any project should be considered as opportunity cost and should be included in our analysis.

(c) *Sunk Cost*: Another potential problem relates to sunk cost. Sunk cost is an outlay that has already incurred and hence should be excluded from capital budgeting analysis. For example, if a company has paid a sum of ₹ 1,00,000 for consultancy charges to a firm for the preparation of a Project Report for analysis to decide whether to take a particular project or not is irrelevant for analysis as sum has already been paid and shall not affect our decision whether project should be undertaken or not.

(d) *Working Capital*: Every big project requires working capital because, for every business investment in working capital is must. Therefore, while evaluating the

projects initial working capital requirement should be treated as cash outflow and at the end of the project its release should be treated as cash inflow. It is important to note that no depreciation is provided on working capital though it might be possible that at the time of its release its value might have been reduced. Further there may be also a possibility that additional working capital may be required during the life of the project. In such cases the additional working capital required is treated as cash outflow at that period of time. Similarly, any reduction in working capital shall be treated as cash inflow. It may be noted that if nothing has been specifically mentioned for the release of working capital it is assumed that full amount has been realized at the end of the project. However, adjustment on account of increase or decrease in working capital needs to be incorporated.

(e) *Allocated Overheads:* As discussed in subject of Cost Accounting allocated overheads are charged on the basis of some rational basis such as machine hour, labour hour, direct material consumption etc. Since, expenditures already incurred are allocated to new proposal; they should not be considered as cash flows. However, it is expected that overhead cost shall be increased due to acceptance of any proposal then incremental overhead cost shall be treated as cash outflow.

(f) *Additional Capital Investment:* It is not necessary that capital investment shall be required in the beginning of the project. It can also be required during the continuance of the project. In such cases it shall be treated as cash outflows.

**Categories of Cash Flows:** It is helpful to place project cash flows into three categories:-

**a) Initial Cash Outflow:** The initial cash out flow for a project depends upon the type of capital investment decision as follows:-

(i) If decision is related to investment in a fresh proposal or an expansion decision then initial cash outflow shall be calculated as follows:

$$\begin{aligned}
 &\text{Cost of New Asset(s)} \\
 &+ \text{Installation/Set-Up Costs} \\
 &+ \text{Investment in Working Capital} \\
 &= \text{Initial Cash Outflow}
 \end{aligned}$$

(ii) If decision is related to replacement decision then initial cash outflow shall be calculated as follows:

$$\begin{aligned}
 &\text{Cost of New Asset(s)} \\
 &+ \text{Installation/Set-Up Costs} \\
 &+ (-) \text{Increase (Decrease) in Net Working Capital Level} \\
 &- \text{Net Proceeds from sale of Old Asset (If it is a replacement situation)}
 \end{aligned}$$

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$$\begin{aligned} &+(-) \text{ Taxes (tax saving/ loss) due to sale of Old Asset (If it is a replacement situation)} \\ &= \text{Initial Cash Outflow} \end{aligned}$$

**b) Interim Cash Flows:** After making the initial cash outflow that is necessary to begin implementing a project, the firm hopes to get benefit from the future cash inflows generated by the project. As mentioned earlier calculation of cash flows depends on the fact whether analysis is related to fresh project or modernization of existing facilities or replacement of existing machined decision.

(i) New Project: If analysis is related to a fresh or completely a new project then interim cash flow is calculated as follows:-

$$\begin{aligned} &\text{Profit after Tax (PAT)} \\ &+ \text{ Non-Cash Expenses (e.g. Depreciation)} \\ &- (+) \text{ Net increase (decrease) in Working Capital} \\ &= \text{Interim net cash flow for the period} \end{aligned}$$

(ii) Similarly interim cash flow in case of replacement decision shall be calculated as follows:

$$\begin{aligned} &\text{Net increase (decrease) in Operating Revenue} \\ &- (+) \text{ Net increase (decrease) in Operating Expenses} \\ &= \text{Net change in income before taxes} \\ &- (+) \text{ Net increase (decrease) in taxes} \\ &= \text{Net change in income after taxes} \\ &+(-) \text{ Net increase (decrease) in depreciation charges} \\ &= \text{Incremental net cash flow for the period} \end{aligned}$$

**c) Terminal-Year Incremental Net Cash Flow:** We now pay attention to the Net Cash Flow in the terminal year of the project. For the purpose of Terminal Year we will first calculate the incremental net cash flow for the period as calculated in point (b) above and further to it we will make adjustments in order to arrive at Terminal-Year Incremental Net Cash flow as follows:-

$$\begin{aligned} &\text{Final salvage value (disposal costs) of asset} \\ &+ \text{ Interim Cash Flow} \\ &- (+) \text{ Taxes (tax saving) due to sale or disposal of asset (Including Depreciation)} \\ &+ \text{ Release of Net Working Capital} \\ &= \text{Terminal Year incremental net cash flow} \end{aligned}$$



## 6.6 Basic Principles for Measuring Project Cash Flows

For developing the project cash flows the following principles must be kept in mind:

**6.6.1 Block of Assets and Depreciation:** From above discussion it is clear that tax shield/ benefit from depreciation is considered while calculating cash flows from the project. However, in India taxable income is calculated as per the provisions of Income Tax Act 1961. The treatment of deprecation is based on the concept of "Block of Assets", which means a group of assets falling within a particular class of assets. This class of assets can be building, machinery, furniture etc. in respect of which depreciation is charged at same rate. The treatment of tax depends on the fact whether block of asset consist of one asset or several assets. To understand the concept of block of asset let us discuss an example.

### Example

Suppose A Ltd. acquired a new machinery for ₹ 1,00,000 depreciable at 20% as per Written Down Value (WDV) method. The machine has an expected life of 5 years with salvage value of ₹ 10,000. The treatment of Depreciation/ Short Term Capital Loss in the 5<sup>th</sup> year in two cases shall be as follows:

Depreciation for initial 4 years shall be common and WDV at the beginning of the 5<sup>th</sup> year shall be computed as follows:

	₹
Purchase Price of Machinery	1,00,000
Less: Depreciation @20% for year 1	20,000
WDV at the end of year 1	80,000
Less: Depreciation @20% for year 2	16,000
WDV at the end of year 2	64,000
Less: Depreciation @20% for year 3	12,800
WDV at the end of year 3	51,200
Less: Depreciation @20% for year 4	10,240
WDV at the end of year 4	40,960

(i) *Case 1: There is no other asset in the Block:* When there is one asset in the block and block shall cease to exist at the end of 5<sup>th</sup> year no depreciation shall be charged in this year and tax benefit/loss on Short Term Capital Loss/ Gain shall be calculated as follows:

	₹
WDV at the beginning of year 5	40,960
Less: Sale value of Machine	10,000
Short Term Capital Loss	30,960
Tax Benefit on STCL @ 30%	9,288

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(ii) *Case 2: More than one asset exists in the Block:* When more than one asset exists in the block and depreciation shall be charged in the terminal year (5<sup>th</sup> year) in which asset is sold. The WDV on which depreciation be charged shall be calculated by deducting sale value from the WDV in the beginning of the year. Tax benefit on Depreciation shall be calculated as follows:

	₹
WDV at the beginning of year 5	40,960
Less: Sale value of Machine	10,000
WDV	30,960
Depreciation @20%	6,192
Tax Benefit on Depreciation @ 30%	1,858

Now suppose if in above two cases sale value of machine is ₹ 50,000, then no depreciation shall be provided in case 2 and tax loss on Short Term Capital Gain in Case 1 shall be computed as follows:

	₹
WDV at the beginning of year 5	40,960
Less: Sale value of Machine	50,000
Short Term Capital Gain	9,040
Tax Loss on STCG @ 30%	2,712

**6.6.2 Exclusion of Financing Costs Principle:** When cash flows relating to long-term funds are being defined, financing costs of long-term funds (interest on long-term debt and equity dividend) should be excluded from the analysis. The question arises why? The weighted average cost of capital used for evaluating by discounting the cash flows takes into account the cost of long-term funds. Putting it differently, the interest and dividend payments are reflected in the weighted average cost of capital. Hence, if interest on long-term debt and dividend on equity capital are deducted in defining the cash flows, the cost of long-term funds will be counted twice.

The exclusion of financing costs principle means that:

- The interest on long-term debt (or interest) is ignored while computing profits and taxes and;
- The expected dividends are deemed irrelevant in cash flow analysis.

While dividends pose no difficulty as they come only from profit after taxes, interest needs to be handled properly. Since interest is usually deducted in the process of arriving at profit after tax, an amount equal to 'Interest (1 – Tax rate)' should be added back to the figure of Profit

after Tax as shown below:

$$\begin{aligned}
 &\text{Profit Before Interest and Tax (1 - Tax rate)} \\
 &= (\text{Profit Before Tax} + \text{Interest}) (1 - \text{Tax rate}) \\
 &= (\text{Profit Before Tax}) (1 - \text{Tax rate}) + (\text{Interest}) (1 - \text{Tax rate}) \\
 &= \text{Profit After Tax} + \text{Interest (1 - Tax rate)}
 \end{aligned}$$

Thus, whether the tax rate is applied directly to the profit before interest and tax figure or whether the tax – adjusted interest, which is simply interest (1 – tax rate), is added to profit after tax, we get the same result.

### Example

Suppose XYZ Ltd.'s expected profit for the forthcoming 4 years is as follows:

	Year 1 (₹)	Year 2 (₹)	Year 3 (₹)	Year 4 (₹)
Profit before Interest and Tax	10,000	20,000	40,000	50,000

If interest payable is ₹ 5,000 and tax rate is 30% the profit after tax excluding financing cost shall be as follows:

	Year 1 (₹)	Year 2 (₹)	Year 3 (₹)	Year 4 (₹)
Profit before Interest and Tax	10,000	20,000	40,000	50,000
Less: Interest	5,000	5,000	5,000	5,000
	5,000	15,000	35,000	45,000
Less: Tax @ 30%	1,500	4,500	10,500	13,500
Profit after Tax (PAT)	3,500	10,500	24,500	31,500
Add: Interest (1 - t)	3,500	3,500	3,500	3,500
PAT excluding financing cost	7,000	14,000	28,000	35,000

### Alternatively

	Year 1 (₹)	Year 2 (₹)	Year 3 (₹)	Year 4 (₹)
Profit before Interest and Tax	10,000	20,000	40,000	50,000
Less: Tax @ 30%	3,000	6,000	12,000	15,000
PAT excluding financing cost	7,000	14,000	28,000	35,000

**6.6.3 Post-tax Principle:** Tax payments like other payments must be properly deducted in deriving the cash flows. That is, cash flows must be defined in post-tax terms. It is always better to avoid using Pre Tax Cash Flows and using Pre-Tax Discounting Rate.

**Illustration 1:** ABC Ltd is evaluating the purchase of a new project with a depreciable base of ₹ 1,00,000; expected economic life of 4 years and change in earnings before taxes and depreciation of ₹ 45,000 in year 1, ₹30,000 in year 2, ₹25,000 in year 3 and ₹35,000 in year 4. Assume straight-line depreciation and a 20% tax rate. You are required to compute relevant cash flows.

**Solution**

	₹			
	Years			
	1	2	3	4
Earnings before tax and depreciation	45,000	30,000	25,000	35,000
Less: Depreciation	25,000	25,000	25,000	25,000
Earnings before tax	20,000	5,000	0	10,000
Less: Tax @20%	4,000	1,000	0	2,000
	16,000	4,000	0	8,000
Add: Depreciation	25,000	25,000	25,000	25,000
Net Cash flow	41,000	29,000	25,000	33,000

**Working Note:**

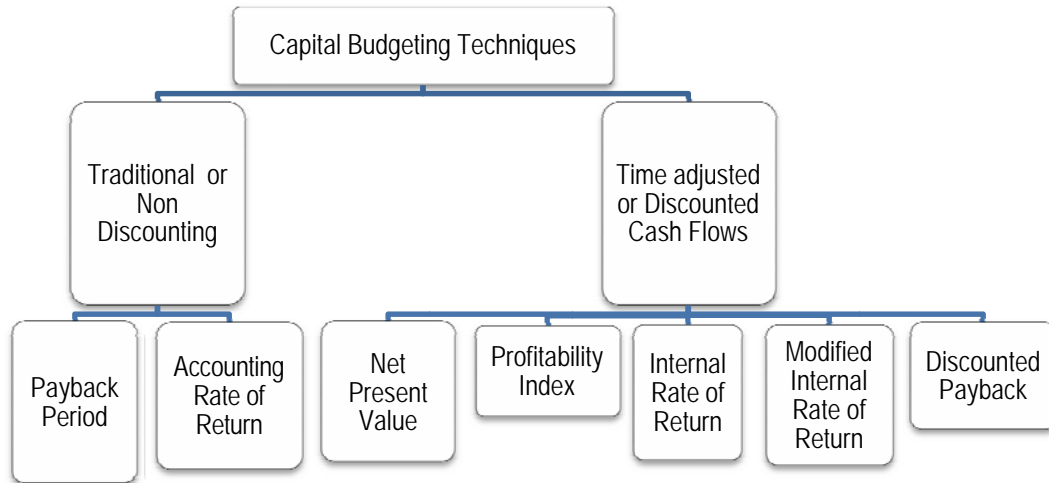
Depreciation = ₹1, 00,000÷4

= ₹25,000

## 6.7 Capital Budgeting Techniques

In order to maximise the return to the shareholders of a company, it is important that the best or most profitable investment projects are selected as the results for making a bad long-term investment decision can be both financially and strategically devastating, particular care needs to be taken with investment project selection and evaluation.

There are a number of techniques available for appraisal of investment proposals and can be classified as presented below:



Organizations may use any or more of capital investment evaluation techniques; some organizations use different methods for different types of projects while others may use multiple methods for evaluating each project. These techniques have been discussed below – net present value, profitability index, internal rate of return, modified internal rate of return, payback period, and accounting (book) rate of return.

**6.7.1 Payback Period:** The payback period of an investment is the length of time required for the cumulative total net cash flows from the investment to equal the total initial cash outlays. At that point in time, the investor has recovered the money invested in the project.

Steps:-

- (a) The first steps in calculating the payback period is determining the total initial capital investment and
- (b) The second step is calculating/estimating the annual expected after-tax net cash flows over the useful life of the investment.

1. When the net cash flows are uniform over the useful life of the project, the number of years in the payback period can be calculated using the following equation:

$$\text{Payback period} = \frac{\text{Total initial capital investment}}{\text{Annual expected after - tax net cash inflow}}$$

#### Example

Suppose a project costs ₹ 20,00,000 and yields annually a profit of ₹ 3,00,000 after depreciation @ 12½% (straight line method) but before tax 50%. The first step would be to calculate the cash inflow from this project. The cash inflow is ₹ 4,00,000 calculated as follows: :

	₹
Profit before tax	3,00,000
Less : Tax @ 50%	<u>1,50,000</u>
Profit after tax	1,50,000
Add : Depreciation written off	<u>2,50,000</u>
Total cash inflow	<u>4,00,000</u>

While calculating cash inflow, depreciation is added back to profit after tax since it does not result in cash outflow. The cash generated from a project therefore is equal to profit after tax plus depreciation. The payback period of the project shall be:

$$\text{Payback period} = \frac{\text{₹ } 20,00,000}{4,00,000} = 5 \text{ Years}$$

Some Accountants calculate payback period after discounting the cash flows by a predetermined rate and the payback period so calculated is called, 'Discounted payback period' (discussed later on).

- When the annual net cash flows are not uniform, the cumulative cash inflow from operations must be calculated for each year. The payback period shall be corresponding period when total of cumulative cash inflows is equal to the initial capital investment. However, if exact sum does not match then the period in which it lies should be identified. After that we need to compute the fraction of the year that is needed to complete the total payback. This method can be understood with the help of an example

#### Example

Suppose XYZ Ltd. is analyzing a project requiring an initial cash outlay of ₹ 2,00,000 and expected to generate cash inflows as follows:

Year	Annual Cash Inflows
1	80,000
2	60,000
3	60,000
4	20,000

Its payback period shall be computed by using cumulative cash flows as follows:

Year	Annual Cash Inflows	Cumulative Cash Inflows	
1	80,000	80,000	
2	60,000	1,60,000	
3	60,000	2,00,000	←
4	20,000	2,20,000	

Suppose if in above case had the initial outlay been ₹ 2,05,000 then payback period shall be computed as follows:

Year	Annual Cash Inflows	Cumulative Cash Inflows
1	80,000	80,000
2	60,000	1,60,000
3	60,000	2,00,000
4	20,000	2,20,000 ←

From above table it is clear that payback period shall lie between 3 to 4 years. Since upto 3 years a sum of ₹ 2,00,000 shall be recovered balance of ₹ 5,000 shall be recovered in the part (fraction) of 4<sup>th</sup> year computed as follows:

$$\frac{20,000}{5,000} = \frac{1}{4} \text{ year}$$

Thus, total cash outlay of ₹ 20,500 shall be recovered in 3¼ years' time.

#### **Advantages**

- It is easy to compute.
- It is easy to understand as it provides a quick estimate of the time needed for the organization to recoup the cash invested.
- The length of the payback period can also serve as an estimate of a project's risk; the longer the payback period, the riskier the project as long-term predictions are less reliable. In some industries with high obsolescence risk like software industry or in situations where an organization is short on cash, short payback periods often become the determining factor for investments.

#### **Limitations**

- It ignores the time value of money. As long as the payback periods for two projects are the same, the payback period technique considers them equal as investments, even if one project generates most of its net cash inflows in the early years of the project while the other project generates most of its net cash inflows in the latter years of the payback period.
- A second limitation of this technique is its failure to consider an investment's total profitability; it only considers cash flows from the initiation of the project until its payback period and ignores cash flows after the payback period.
- Lastly, use of the payback period technique may cause organizations to place too much emphasis on short payback periods thereby ignoring the need to invest in long-term projects that would enhance its competitive position.

**6.7.2 Payback Reciprocal:** As the name indicates it is the reciprocal of payback period. A major drawback of the payback period method of capital budgeting is that it does not indicate any cut off period for the purpose of investment decision. It is, however, argued that the reciprocal of the payback would be a close approximation of the Internal Rate of Return (later discussed in detail) if the life of the project is at least twice the payback period and the project generates equal amount of the annual cash inflows. In practice, the payback reciprocal is a helpful tool for quickly estimating the rate of return of a project provided its life is at least twice the payback period.

The payback reciprocal can be calculated as follows:

$$\frac{\text{Average annual cash in flow}}{\text{Initial investment}}$$

**Example**

Suppose a project requires an initial investment of ₹20,000 and it would give annual cash inflow of ₹4,000. The useful life of the project is estimated to be 5 years. In this example payback reciprocal will be :

$$\frac{₹ 4,000 \times 100}{₹ 20,000} = 20\%$$

The above payback reciprocal provides a reasonable approximation of the internal rate of return, i.e. 19%.

**6.7.3 Accounting (Book) Rate of Return (ARR):** The accounting rate of return of an investment measures the average annual net income of the project (incremental income) as a percentage of the investment.

$$\text{Accounting rate of return} = \frac{\text{Average annual net income}}{\text{Investment}}$$

The numerator is the average annual net income generated by the project over its useful life. The denominator can be either the initial investment (including installation cost) or the average investment over the useful life of the project. Average investment means the average amount of fund remained blocked during the lifetime of the project under consideration. Further ARR can be calculated in a number of ways as shown in the following example.

**Example**

Suppose Times Ltd. is going to invest in a project a sum of ₹ 3,00,000 having a life span of 3 years. Salvage value of machine is ₹ 90,000. The profit before depreciation for each year is ₹ 1,50,000.

The Profit after Tax and value of Investment in the Beginning and at the End of the each year shall be as follows:



Year	PBT (₹)	Depreciation (₹)	Profit after Dep. (₹)	Value of Investment in (₹)	
				Beginning	End
1	1,50,000	70,000	80,000	3,00,000	2,30,000
2	1,50,000	70,000	80,000	2,30,000	1,60,000
3	1,50,000	70,000	80,000	1,60,000	90,000

The ARR can be computed by following methods as follows:

(a) Version 1: Annual Basis

$$\text{ARR} = \frac{\text{Pr ofit after Depreciation}}{\text{Investment in the begining of the year}}$$

Year	
1	$\frac{80,000}{3,00,000} = 26.67\%$
2	$\frac{80,000}{2,30,000} = 34.78\%$
3	$\frac{80,000}{1,60,000} = 50\%$

$$\text{Average ARR} = \frac{26.67\% + 34.78\% + 50.00\%}{3} = 37.15\%$$

(b) Version 2: Total Investment Basis

$$\text{ARR} = \frac{\text{Average Annual Pr ofit}}{\text{Investment in the begining}} \times 100$$

$$= \frac{(80,000 + 80,000 + 80,000) / 3}{3,00,000} \times 100$$

$$= 26.67\%$$

(c) Version 3: Average Investment Basis

$$\text{ARR} = \frac{\text{Average Annual Pr ofit}}{\text{Average Investment}} \times 100$$

$$\text{Average Investment} = (\text{₹ } 3,00,000 + \text{₹ } 90,000) / 2 = \text{₹ } 1,95,000$$

or  $\frac{1}{2}(\text{Initial Investment} - \text{Salvage Value}) + \text{Salvage Value}$

$$= \frac{1}{2}(\text{₹ } 3,00,000 - \text{₹ } 90,000) + \text{₹ } 90,000 = \text{₹ } 1,95,000$$

$$= \frac{80,000}{1,95,000} \times 100$$

$$= 41.03\%$$

Further, it is important to note that project may also require additional working capital during its life in addition to initial working capital. In such situation formula for the calculation of average investment shall be modified as follows:

$$\frac{1}{2}(\text{Initial Investment} - \text{Salvage Value}) + \text{Salvage Value} + \text{Additional Working Capital}$$

Continuing above example suppose a sum of ₹ 45,000 is required as additional working capital during the project life then average investment shall be:

$$= \frac{1}{2}(\text{₹ } 3,00,000 - \text{₹ } 90,000) + \text{₹ } 90,000 + \text{₹ } 45,000 = \text{₹ } 2,40,000 \text{ and}$$

$$\text{ARR} = \frac{80,000}{2,40,000} \times 100 = 33.33\%$$

Some organizations prefer the initial investment because it is objectively determined and is not influenced by either the choice of the depreciation method or the estimation of the salvage value. Either of these amounts is used in practice but it is important that the same method be used for all investments under consideration.

#### ***Advantages***

- This technique uses readily available data that is routinely generated for financial reports and does not require any special procedures to generate data.
- This method may also mirror the method used to evaluate performance on the operating results of an investment and management performance. Using the same procedure in both decision-making and performance evaluation ensures consistency.
- Lastly, the calculation of the accounting rate of return method considers all net incomes over the entire life of the project and provides a measure of the investment's profitability.

#### ***Limitations***

- The accounting rate of return technique, like the payback period technique, ignores the time value of money and considers the value of all cash flows to be equal.
- The technique uses accounting numbers that are dependent on the organization's choice of accounting procedures, and different accounting procedures, e.g., depreciation methods, can lead to substantially different amounts for an investment's net income and book values.
- The method uses net income rather than cash flows; while net income is a useful

measure of profitability, the net cash flow is a better measure of an investment's performance.

- Furthermore, inclusion of only the book value of the invested asset ignores the fact that a project can require commitments of working capital and other outlays that are not included in the book value of the project.

**Illustration 2:** A project requiring an investment of ₹ 10,00,000 and it yields profit after tax and depreciation which is as follows:

Years	Profit after tax and depreciation ₹
1	50,000
2	75,000
3	1,25,000
4	1,30,000
5	<u>80,000</u>
Total	<u>4,60,000</u>

Suppose further that at the end of 5 years, the plant and machinery of the project can be sold for ₹ 80,000. Determine Average Rate of Return.

#### Solution

In this case the rate of return can be calculated as follows:

$$\frac{\text{Total Profit/No. of years}}{\text{Average investment/Initial Investment}} \times 100$$

- (a) If Initial Investment is considered then,

$$= \frac{92,000}{10,00,000} \times 100 = 9.2\%$$

This rate is compared with the rate expected on other projects, had the same funds been invested alternatively in those projects. Sometimes, the management compares this rate with the minimum rate (called-cut off rate) they may have in mind. For example, management may decide that they will not undertake any project which has an average annual yield after tax less than 20%. Any capital expenditure proposal which has an average annual yield of less than 20% will be automatically rejected.

- (b) If Average investment is considered, then,

$$= \frac{92,000}{\text{Average investment}} \times 100 = \frac{92,000}{5,40,000} \times 100 = 17\%$$

Where,

$$\begin{aligned}\text{Average Investment} &= \frac{1}{2} (\text{Initial investment} - \text{Salvage value}) + \text{Salvage value} \\ &= 80,000 + \frac{1}{2} (10,00,000 - 80,000) \\ &= 80,000 + 4,60,000 = 5,40,000\end{aligned}$$

**6.7.4 Net Present Value Technique (NPV):** The net present value technique is a discounted cash flow method that considers the time value of money in evaluating capital investments. An investment has cash flows throughout its life, and it is assumed that a rupee of cash flow in the early years of an investment is worth more than a rupee of cash flow in a later year.

The net present value method uses a specified discount rate to bring all subsequent net cash inflows after the initial investment to their present values (the time of the initial investment is year 0).

#### **Determining Discount Rate**

Theoretically, the discount rate or desired rate of return on an investment is the rate of return the firm would have earned by investing the same funds in the best available alternative investment that has the same risk. Determining the best alternative opportunity available is difficult in practical terms so rather than using the true opportunity cost, organizations often use an alternative measure for the desired rate of return. An organization may establish a minimum rate of return that all capital projects must meet; this minimum could be based on an industry average or the cost of other investment opportunities. Many organizations choose to use the overall cost of capital or Weighted Average Cost of Capital (WACC) that an organization has incurred in raising funds or expects to incur in raising the funds needed for an investment.

The net present value of a project is the amount, in current value of rupees, the investment earns after paying cost of capital in each period.

Net present value = Present value of net cash inflow - Total net initial investment

Since it might be possible that some additional investment may also be required during the life time of the project then appropriate formula shall be:

Net present value = Present value of cash inflow - Present value of cash outflow

The steps to calculating net present value are:-

1. Determine the net cash inflow in each year of the investment
2. Select the desired rate of return or discounting rate or Weighted Average Cost of Capital.
3. Find the discount factor for each year based on the desired rate of return selected.
4. Determine the present values of the net cash flows by multiplying the cash flows by respective the discount factors of respective period called Present Value (PV) of Cash flows

5. Total the amounts of all PVs of Cash Flows

**Decision Rule:**

If  $NPV \geq 0$  Accept the Proposal

If  $NPV \leq 0$  Reject the Proposal

**Illustration 3:** Compute the net present value for a project with a net investment of ₹1,00,000 and net cash flows year one is ₹55,000; for year two is ₹80,000 and for year three is ₹15,000. Further, the company's cost of capital is 10%?

[PVIF @ 10% for three years are 0.909, 0.826 and 0.751]

**Solution**

Year	Net Cash Flows	PVIF @ 10%	Discounted Cash Flows
0	(1,00,000)	1.000	(1,00,000)
1	55,000	0.909	49,995
2	80,000	0.826	66,080
3	15,000	0.751	<u>11,265</u>
Net Present Value			<u>27,340</u>

**Recommendation:** Since the net present value of the project is positive, the company should accept the project.

**Illustration 4:** ABC Ltd is a small company that is currently analyzing capital expenditure proposals for the purchase of equipment; the company uses the net present value technique to evaluate projects. The capital budget is limited to ₹ 500,000 which ABC Ltd believes is the maximum capital it can raise. The initial investment and projected net cash flows for each project are shown below. The cost of capital of ABC Ltd is 12%. You are required to compute the NPV of the different projects.

	Project A	Project B	Project C	Project D
Initial Investment	200,000	190,000	250,000	210,000
Project Cash Inflows				
Year 1	50,000	40,000	75,000	75,000
2	50,000	50,000	75,000	75,000
3	50,000	70,000	60,000	60,000
4	50,000	75,000	80,000	40,000
5	50,000	75,000	100,000	20,000

**Solution****Calculation of net present value:**

	Present				
<i>Period</i>	<i>value factor</i>	<i>Project A</i>	<i>Project B</i>	<i>Project C</i>	<i>Project D</i>
0	1.000	(2,00,000)	(1,90,000)	(2,50,000)	(2,10,000)
1	0.893	44,650	35,720	66,975	66,975
2	0.797	39,850	39,850	59,775	59,775
3	0.712	35,600	49,840	42,720	42,720
4	0.636	31,800	47,700	50,880	25,440
5	0.567	<u>28,350</u>	<u>42,525</u>	<u>56,700</u>	<u>11,340</u>
Net present value		<u>(19,750)</u>	<u>25,635</u>	<u>27,050</u>	<u>(3,750)</u>

**Advantages**

- NPV method takes into account the time value of money.
- The whole stream of cash flows is considered.
- The net present value can be seen as the addition to the wealth of share holders. The criterion of NPV is thus in conformity with basic financial objectives.
- The NPV uses the discounted cash flows i.e., expresses cash flows in terms of current rupees. The NPVs of different projects therefore can be compared. It implies that each project can be evaluated independent of others on its own merit.

**Limitations**

- It involves difficult calculations.
- The application of this method necessitates forecasting cash flows and the discount rate. Thus accuracy of NPV depends on accurate estimation of these two factors which may be quite difficult in practice.

The decision under NPV method is based on absolute measure. It ignores the difference in initial outflows, size of different proposals etc. while evaluating mutually exclusive projects.

**6.7.5 Desirability Factor/Profitability Index/Present Value Index Method (PI):** In the above illustration the students may have seen how with the help of discounted cash flow technique, the two alternative proposals for capital expenditure can be compared. In certain cases we have to compare a number of proposals each involving different amounts of cash inflows.

One of the methods of comparing such proposals is to work out what is known as the '*Desirability factor*', or '*Profitability index*' or '*Present Value Index Method*'.

*Mathematically:*

The desirability factor is calculated as below:

$$\frac{\text{Sum of discounted cash in flows}}{\text{Initial cash outlay Or Total discounted cash outflow (as the case may)}}$$

**Decision Rule:**

If  $PI \geq 1$       Accept the Proposal

If  $PI \leq 1$       Reject the Proposal

**Illustration 5:** Suppose we have three projects involving discounted cash outflow of ₹ 5,50,000, ₹ 75,000 and ₹ 1,00,20,000 respectively. Suppose further that the sum of discounted cash inflows for these projects are ₹ 6,50,000, ₹ 95,000 and ₹ 1,00,30,000 respectively. Calculate the desirability factors for the three projects.

**Solution**

The desirability factors for the three projects would be as follows:

$$1. \quad \frac{\text{₹ } 6,50,000}{\text{₹ } 5,50,000} = 1.18$$

$$2. \quad \frac{\text{₹ } 95,000}{\text{₹ } 75,000} = 1.27$$

$$3. \quad \frac{\text{₹ } 1,00,30,000}{\text{₹ } 1,00,20,000} = 1.001$$

It would be seen that in absolute terms project 3 gives the highest cash inflows yet its desirability factor is low. This is because the outflow is also very high. The Desirability/Profitability Index factor helps us in ranking various projects.

### **Advantages**

- The method also uses the concept of time value of money and is a better project evaluation technique than NPV.

### **Limitations**

- Profitability index fails as a guide in resolving capital rationing where projects are indivisible.
- Once a single large project with high NPV is selected, possibility of accepting several small projects which together may have higher NPV than the single project is excluded.
- Also situations may arise where a project with a lower profitability index selected may generate cash flows in such a way that another project can be taken up one or two years later, the total NPV in such case being more than the one with a project with highest Profitability Index.

The Profitability Index approach thus cannot be used indiscriminately but all other type of alternatives of projects will have to be worked out.

**6.7.6 Internal Rate of Return Method (IRR):** The internal rate of return method considers the time value of money, the initial cash investment, and all cash flows from the investment. But unlike the net present value method, the internal rate of return method does not use the desired rate of return but estimates the discount rate that makes the present value of subsequent net cash flows equal to the initial investment. This discount rate is called IRR.

**IRR Definition:** Internal rate of return for an investment proposal is the discount rate that equates the present value of the expected net cash flows with the initial cash outflow.

This IRR is then compared to a criterion rate of return that can be the organization's desired rate of return for evaluating capital investments.

**Calculating IRR:** The procedures for computing the internal rate of return vary with the pattern of net cash flows over the useful life of an investment.

**Scenario 1:** For an investment with uniform cash flows over its life, the following equation is used:

*Step 1:* Total initial investment = Annual net cash flow x Annuity discount factor of the discount rate for the number of periods of the investment's useful life

If A is the annuity discount factor, then

$$A = \frac{\text{Total initial cash disbursements and commitments for the investment}}{\text{Annual (equal) net cash flows from the investment}}$$

*Step 2:* Once A has been calculated, the discount rate is the interest rate that has the same discounting factor as A in the annuity table along the row for the number of periods of the useful life of the investment. If exact value of 'A' could be find in Present Value Annuity Factor (PVAf) table corresponding to the period of the project the respective discounting factor or rate shall be IRR. However, it rarely happens therefore we follow the method discussed below:

*Step 1:* Compute approximate payback period also called fake payback period.

*Step 2:* Locate this value in PVAf table corresponding to period of life of the project. The value may be falling between two discounting rates.

*Step 3:* Discount cash flows using these two discounting rates.

*Step 4:* Use following Interpolation Formula:

$$= LR + \frac{\text{NPV at LR}}{\text{NPV at LR} - \text{NPV at HR}} \times (HR - LR)$$

Where

LR = Lower Rate

HR = Higher Rate



**Illustration 6:** A Ltd. is evaluating a project involving an outlay of ₹ 10,00,000 resulting in an annual cash inflow of ₹ 2,50,000 for 6 years. Assuming salvage value of the project is zero determine the IRR of the project.

**Solution**

First of all we shall find an approximation of the payback period:

$$\frac{1,00,000}{25,000} = 4$$

Now we shall this figure in the PVAF table corresponding to 6 year row.

The value 4 lies between values 4.111 and 3.998 correspondingly discounting rates 12% and 13% respectively.

NPV @ 12%

$$NPV_{12\%} = (1,00,000) + 4.111 \times 25,000 = 2,775$$

$$NPV_{13\%} = (1,00,000) + 3.998 \times 25,000 = (50)$$

The internal rate of return is, thus, more than 12% but less than 13%. The exact rate can be obtained by interpolation:

$$\begin{aligned} IRR &= 12\% + \frac{2,775}{2,775 - (50)} \times (13\% - 12\%) \\ &= 12\% + \frac{2,775}{2,825} = 12.98\% \end{aligned}$$

$$IRR = 12.98\%$$

**Scenario 2:** When the net cash flows are not uniform over the life of the investment, the determination of the discount rate can involve trial and error and interpolation between discounting rates as mentioned above. However, IRR can also be found out by using following procedure:

Step 1: Discount the cash flow at any random rate say 10%, 15% or 20% randomly.

Step 2: If resultant NPV is negative then discount cash flows again by lower discounting rate to make NPV positive. Conversely, if resultant NPV is positive then again discount cash flows by higher discounting rate to make NPV negative.

Step 3: Use following Interpolation Formula:

$$= LR + \frac{NPV \text{ at LR}}{NPV \text{ at LR} - NPV \text{ at HR}} \times (HR - LR)$$

Where

LR = Lower Rate

HR = Higher Rate

**Illustration 7:** Calculate the internal rate of return of an investment of ₹ 1, 36,000 which yields the following cash inflows:

Year	Cash Inflows (in ₹)
1	30,000
2	40,000
3	60,000
4	30,000
5	20,000

**Solution**

Let us discount cash flows by 10%.

Year	Cash Inflows (₹)	Discounting factor at 10%	Present Value (₹)
1	30,000	0.909	27,270
2	40,000	0.826	33,040
3	60,000	0.751	45,060
4	30,000	0.683	20,490
5	20,000	0.621	12,420
Total present value			1,38,280

The present value at 10% comes to ₹ 1,38,280, which is more than the initial investment. Therefore, a higher discount rate is suggested, say, 12%.

Year	Cash Inflows (₹)	Discounting factor at 12%	Present Value (₹)
1	30,000	0.893	26,790
2	40,000	0.797	31,880
3	60,000	0.712	42,720
4	30,000	0.636	19,080
5	20,000	0.567	11,340
Total present value			1,31,810

The internal rate of return is, thus, more than 10% but less than 12%. The exact rate can be obtained by interpolation:

$$\begin{aligned}
 \text{IRR} &= \left[ 10 + \left( \frac{\text{₹ } 1,38,280 - \text{₹ } 1,36,000}{\text{₹ } 1,38,280 - \text{₹ } 1,31,810} \right) \right] \times 2 \\
 &= 10 + \left( \frac{2280}{6470} \times 2 \right) = 10 + 0.70 \\
 \text{IRR} &= 10.70\%
 \end{aligned}$$

**Illustration 8:** A company proposes to install machine involving a capital cost of ₹ 3,60,000. The life of the machine is 5 years and its salvage value at the end of the life is nil. The machine will produce the net operating income after depreciation of ₹ 68,000 per annum. The company's tax rate is 45%.

The Net Present Value factors for 5 years are as under:

Discounting rate	:	14	15	16	17	18
Cumulative factor	:	3.43	3.35	3.27	3.20	3.13

You are required to calculate the internal rate of return of the proposal.

### Solution

#### Computation of Cash inflow per annum (₹)

Net operating income per annum	68,000
Less: Tax @ 45%	<u>30,600</u>
Profit after tax	37,400
Add: Depreciation (₹3,60,000 / 5 years)	72,000
Cash inflow	<u>1,09,400</u>

The IRR of the investment can be found as follows:

$$NPV = -₹3,60,000 + ₹1,09,400 (PVA F_{5,r}) = 0$$

$$\text{or } PVA F_{5,r} (\text{Cumulative factor}) = \frac{₹ 3,60,000}{₹ 1,09,400} = 3.29$$

#### Computation of Internal Rate of Return

Discounting Rate	15%	16%
Cumulative factor	3.35	3.27
PV of Inflows	3,66,490	3,57,738
	(₹1,09,400 × 3.35)	(₹1,09,400 × 3.27)
Initial outlay (₹)	3,60,000	3,60,000
NPV (₹)	6,490	(2,262)

$$IRR = 15 + \left[ \frac{6,490}{6,490 + 2,262} \right] = 15 + 0.74$$

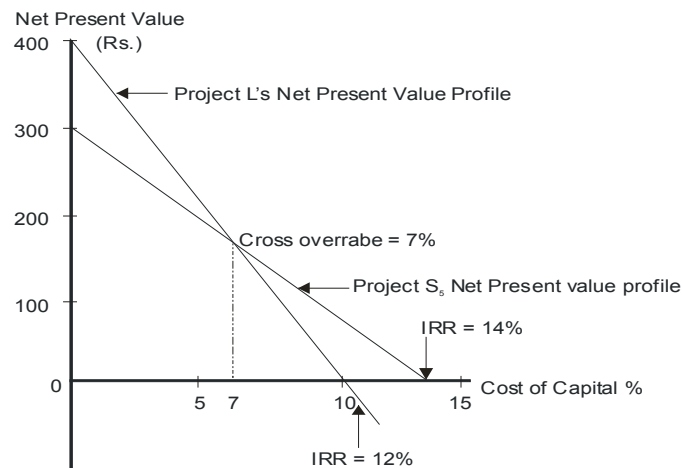
$$= 15.74\%.$$

**6.7.6.1 Acceptance Rule:** The use of IRR, as a criterion to accept capital investment decision involves a comparison of IRR with the required rate of return known as cut off rate. The project should be accepted if IRR is greater than cut-off rate. If IRR is equal to cut off rate the firm is indifferent. If IRR less than cut off rate the project is rejected. Thus,

If  $IRR \geq$  Cut-off Rate or WACC      Accept the Proposal

If  $PI \leq$  Cut-off Rate or WACC      Reject the Proposal

**6.7.6.2 Internal Rate of Return and Mutually Exclusive Projects:** Projects are called mutually exclusive, when the selection of one precludes the selection of others e.g. in case a company owns a piece of land which can be put to use for either of the two different projects S or L, then such projects are mutually exclusive to each other i.e. the selection of one project necessarily means the rejection of the other. Refer to the figure below:



As long as the cost of capital is greater than the crossover rate of 7 %, then (1)  $NPV^S$  is larger than  $NPV^L$  and (2)  $IRR^S$  exceeds  $IRR^L$ . Hence, if the cut off rate or the cost of capital is greater than 7%, both the methods shall lead to selection of project S. However, if the cost of capital is less than 7%, the NPV method ranks Project L higher, but the IRR method indicates that the Project S is better.

As can be seen from the above discussion, mutually exclusive projects can create problems with the IRR technique because IRR is expressed as a percentage and does not take into account the scale of investment or the quantum of money earned.

Let us consider another example of two mutually exclusive projects A and B with the following details,

*Cash flows*

	<i>Year 0</i>	<i>Year 1</i>	<i>IRR</i>	<i>NPV(10%)</i>
Project A	(₹ 1,00,000)	₹ 1,50,000	50%	₹ 36,360
Project B	(₹ 5,00,000)	₹ 6,25,000	25%	₹ 68,180

Project A earns a return of 50% which is more than what Project B earns; however the NPV of Project B is greater than that of Project A. Acceptance of Project A means that Project B must be rejected since the two Projects are mutually exclusive. Acceptance of Project A also implies that the total investment will be ₹ 4,00,000 less than if Project B had been accepted, ₹

4,00,000 being the difference between the initial investment of the two projects. Assuming that the funds are freely available at 10%, the total capital expenditure of the company should be ideally equal to the sum total of all outflows provided they earn more than 10% along with the chosen project from amongst the mutually exclusive. Hence, in case the smaller of the two Projects i.e. Project A is selected, the implication will be of rejecting the investment of additional funds required by the larger investment. This shall lead to a reduction in the shareholders wealth and thus, such an action shall be against the very basic tenets of Financial Management.

In the above mentioned example the larger of the two projects had the lower IRR, but never the less provided for the wealth maximising choice. However, it is not safe to assume that a choice can be made between mutually exclusive projects using IRR in cases where the larger project also happens to have the higher IRR. Consider the following two Projects A and B with their relevant cash flows;

Year	A	B
	₹	₹
0	(9,00,000)	(8,00,000)
1	7,00,000	62,500
2	6,00,000	6,00,000
3	4,00,000	6,00,000
4	50,000	6,00,000

In this case Project A is the larger investment and also has a higher IRR as shown below,

Year	(₹)	$r = 46\%$	PV(₹)	(₹)	$r = 35\%$	PV(₹)
0	(9,00,000)	1.0	(9,00,000)	(8,00,000)	1.0	(8,00,000)
1	7,00,000	0.6849	4,79,430	62,500	0.7407	46,294
2	6,00,000	0.4691	2,81,460	6,00,000	0.5487	3,29,220
3	4,00,000	0.3213	1,28,520	6,00,000	0.4064	2,43,840
4	50,000	0.2201	11,005	6,00,000	0.3011	1,80,660
			(415)			14

IRR of Project A = 46%

IRR of Project B = 35%

However, in case the relevant discounting factor is taken as 5%, the NPV of the two projects provides a different picture as follows;

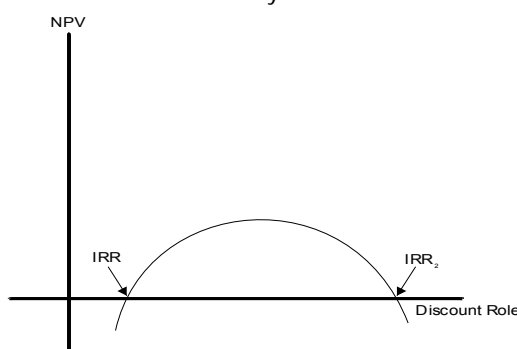
Project A				Project B		
Year	(₹)	$r = 5\%$	PV(₹)	(₹)	$r = 5\%$	PV(₹)
0	(9,00,000)	1.0	(9,00,000)	(8,00,000)	1.0	(8,00,000)
1	7,00,000	0.9524	6,66,680	62,500	0.9524	59,525
2	6,00,000	0.9070	5,44,200	6,00,000	0.9070	5,44,200
3	4,00,000	0.8638	3,45,520	6,00,000	0.8638	5,18,280
4	50,000	0.8227	41,135	6,00,000	0.8227	4,93,620
		NPV	6,97,535			8,15,625

As may be seen from the above, Project B should be the one to be selected even though its IRR is lower than that of Project A. This decision shall need to be taken in spite of the fact that Project A has a larger investment coupled with a higher IRR as compared with Project B. This type of an anomalous situation arises because of the reinvestment assumptions implicit in the two evaluation methods of NPV and IRR.

**6.7.6.3 The Reinvestment Assumption:** The Net Present Value technique assumes that all cash flows can be reinvested at the discount rate used for calculating the NPV. This is a logical assumption since the use of the NPV technique implies that all projects which provide a higher return than the discounting factor are accepted.

In contrast, IRR technique assumes that all cash flows are reinvested at the projects IRR. This assumption means that projects with heavy cash flows in the early years will be favoured by the IRR method vis-à-vis projects which have got heavy cash flows in the later years. This implicit reinvestment assumption means that Projects like A, with cash flows concentrated in the earlier years of life will be preferred by the method relative to Projects such as B.

**6.7.6.4 Multiple Internal Rate of Return:** In cases where project cash flows change signs or reverse during the life of a project e.g. an initial cash outflow is followed by cash inflows and subsequently followed by a major cash outflow, there may be more than one IRR. The following graph of discount rate versus NPV may be used as an illustration;



In such situations if the cost of capital is less than the two IRR's, a decision can be made easily, however otherwise the IRR decision rule may turn out to be misleading as the project should only be invested if the cost of capital is between  $IRR_1$  and  $IRR_2$ . To understand the

concept of multiple IRR it is necessary to understand the implicit re investment assumption in both NPV and IRR techniques.

#### **Advantages**

- This method makes use of the concept of time value of money.
- All the cash flows in the project are considered.
- IRR is easier to use as instantaneous understanding of desirability can be determined by comparing it with the cost of capital
- IRR technique helps in achieving the objective of minimisation of shareholders wealth.

#### **Limitations**

- The calculation process is tedious if there are more than one cash outflows interspersed between the cash inflows, there can be multiple IRR, the interpretation of which is difficult.
- The IRR approach creates a peculiar situation if we compare two projects with different inflow/outflow patterns.
- It is assumed that under this method all the future cash inflows of a proposal are reinvested at a rate equal to the IRR. It is ridiculous to imagine that the same firm has a ability to reinvest the cash flows at a rate equal to IRR.
- If mutually exclusive projects are considered as investment options which have considerably different cash outlays. A project with a larger fund commitment but lower IRR contributes more in terms of absolute NPV and increases the shareholders' wealth. In such situation decisions based only on IRR criterion may not be correct.

**6.7.7 Modified Internal Rate of Return (MIRR):** As mentioned earlier, there are several limitations attached with the concept of the conventional Internal Rate of Return. The MIRR addresses some of these deficiencies e.g., it eliminates multiple IRR rates; it addresses the reinvestment rate issue and produces results which are consistent with the Net Present Value method. This method is also called Terminal Value method.

Under this method, all cash flows, apart from the initial investment, are brought to the terminal value using an appropriate discount rate (usually the Cost of Capital). This results in a single stream of cash inflow in the terminal year. The MIRR is obtained by assuming a single outflow in the zeroth year and the terminal cash inflow as mentioned above. The discount rate which equates the present value of the terminal cash inflow to the zeroth year outflow is called the MIRR.

The decision criterion of MIRR is same as IRR i.e. you accept an investment if MIRR is larger than required rate of return and reject if it is lower than the required rate of return.

**Illustration 9:** *An investment of ₹ 1,36,000 yields the following cash inflows (profits before depreciation but after tax). Determine MIRR considering 8% as cost of capital.*

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Year	₹
1	30,000
2	40,000
3	60,000
4	30,000
5	<u>20,000</u>
	<u>1,80,000</u>

### Solution

Year	Cashflow
	₹
0	1,36,000

The MIRR is calculated on the basis of investing the inflows at the cost of capital. The table below shows the valued of the inflows if they are immediately reinvested at 8%.

Year	Cash flow	@8% reinvestment rate factor factor.	₹
1	30,000	1.3605*	40,815
2	40,000	1.2597	50,388
3	60,000	1.1664	69,984
4	30,000	1.0800	32,400
5	20,000	1.0000	20,000
			<u>2,13,587</u>

\* Investment of ₹ 1 at the end of the year 1 is reinvested for 4 years (at the end of 5 years) shall become  $1(1.08)^4 = 1.3605$ . Similarly reinvestment rate factor for remaining years shall be calculated. Please note investment at the end of 5<sup>th</sup> year shall be reinvested for zero year hence reinvestment rate factor shall be 1.00.

The total cash outflow in year 0 (₹ 1,36,000) is compared with the possible inflow at year 5 and the resulting figure of  $\frac{1,36,000}{2,13,587} = 0.6367$  is the discount factor in year 5. By looking at the year 5 row in the present value tables, you will see that this gives a return of 9%. This means that the ₹ 2,13,587 received in year 5 is equivalent to ₹ 1,36,000 in year 0 if the discount rate is 9%. Alternatively, we can compute MIRR as follows:

$$\text{Total return} = \frac{2,13,587}{1,36,000} = 1.5705$$

$$\text{MIRR} = \sqrt[5]{1.5705} - 1 = 9\%.$$



### 6.7.8 Comparison of Net Present Value and Internal Rate of Return Methods

#### Similarity

- Both the net present value and the internal rate of return methods are discounted cash flow methods which mean that they consider the time value of money.
- Both these techniques consider all cash flows over the expected useful life of the investment.

#### Different conclusion in the following scenarios

There are circumstances/scenarios under which the net present value method and the internal rate of return methods will reach different conclusions. Let's discuss these scenarios:-

#### Scenario 1 – Scale or Size Disparity

Being IRR a relative measure and NPV an absolute measure in case of disparity in scale or size both may give contradicting ranking. This can be understood with the help of following illustration:

**Illustration 10:** Suppose there are two Project A and Project B are under consideration. The cash flows associated with these projects are as follows:

Year	Project A	Project B
0	(1,00,000)	(3,00,000)
1	50,000	1,40,000
2	60,000	1,90,000
3	40,000	1,00,000

Assuming Cost of Capital equal to 10% which project should be accepted as per NPV Method and IRR Method.

#### Solution

##### Net Present Value of Projects

Year	Cash Inflows Project A (₹)	Cash Inflows Project B (₹)	Present Value Factor @ 10%	PV of Project A (₹)	PV of Project B (₹)
0	(1,00,000)	(3,00,000)	1.000	(1,00,000)	(3,00,000)
1	50,000	1,40,000	0.909	45,450	1,27,260
2	60,000	1,90,000	0.826	49,560	1,56,940
3	40,000	1,00,000	0.751	30,040	75,100
				25,050	59,300

*Internal Rate of Returns of projects*

Since by discounting cash flows at 10% we are getting values very far from zero. Therefore, let us discount cash flows using 20% discounting rate.

Year	Cash Inflows Project A (₹)	Cash Inflows Project B (₹)	Present Value Factor @ 20%	PV of Project A (₹)	PV of Project B (₹)
0	(1,00,000)	(3,00,000)	1.000	(1,00,000)	(3,00,000)
1	50,000	1,40,000	0.833	41,650	1,16,620
2	60,000	1,90,000	0.694	41,640	1,31,860
3	40,000	1,00,000	0.579	23,160	57,900
				6,450	6,380

Since by discounting cash flows at 20% we are getting values far from zero. Therefore, let us discount cash flows using 25% discounting rate.

Year	Cash Inflows Project A (₹)	Cash Inflows Project B (₹)	Present Value Factor @ 25%	PV of Project A (₹)	PV of Project B (₹)
0	(1,00,000)	(3,00,000)	1.000	(1,00,000)	(3,00,000)
1	50,000	1,40,000	0.800	40,000	1,12,000
2	60,000	1,90,000	0.640	38,400	1,21,600
3	40,000	1,00,000	0.512	20,480	51,200
				(1,120)	(15,200)

The internal rate of return is, thus, more than 20% but less than 25%. The exact rate can be obtained by interpolation:

$$IRR_A = 20\% + \frac{6,450}{6,450 - (1,120)} \times (25\% - 20\%)$$

$$= 20\% + \left( \frac{6,450}{7,570} \times 5\% \right) = 24.26\%$$

$$IRR_B = 20\% + \frac{6,380}{6,380 - (15,200)} \times (25\% - 20\%)$$

$$= 20\% + \left( \frac{6,380}{21,580} \times 5\% \right) = 21.48\%$$

**Overall Position**

	Project A	Project B
NPV @ 10%	25,050	59,300
IRR	24.26%	21.48%

Thus there is contradiction in ranking by two methods.

**Scenario 2 – Time Disparity in Cash Flows**

It might be possible that overall cash flows may be more or less same in the projects but there may be disparity in their flows i.e. larger part of cash inflows may be occurred in the beginning or end of the project. In such situation there may be difference in the ranking of projects as per two methods.

**Illustration 11:** Suppose ABC Ltd. is considering two Project X and Project Y for investment. The cash flows associated with these projects are as follows:

Year	Project X	Project Y
0	(2,50,000)	(3,00,000)
1	2,00,000	50,000
2	1,00,000	1,00,000
3	50,000	3,00,000

Assuming Cost of Capital be 10%, which project should be accepted as per NPV Method and IRR Method.

**Solution****Net Present Value of Projects**

Year	Cash Inflows Project X (₹)	Cash Inflows Project Y (₹)	Present Value Factor @ 10%	PV of Project X (₹)	PV of Project Y (₹)
0	(2,50,000)	(3,00,000)	1.000	(2,50,000)	(3,00,000)
1	2,00,000	50,000	0.909	1,81,800	45,450
2	1,00,000	1,00,000	0.826	82,600	82,600
3	50,000	3,00,000	0.751	37,550	2,25,300
				51,950	53,350

**Internal Rate of Returns of projects**

Since by discounting cash flows at 10% we are getting values far from zero. Therefore, let us discount cash flows using 20% discounting rate.

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Year	Cash Inflows Project X (₹)	Cash Inflows Project Y (₹)	Present Value Factor @ 20%	PV of Project X (₹)	PV of Project Y (₹)
0	(2,50,000)	(3,00,000)	1.000	(2,50,000)	(3,00,000)
1	2,00,000	50,000	0.833	1,66,600	41,650
2	1,00,000	1,00,000	0.694	69,400	69,400
3	50,000	3,00,000	0.579	28,950	1,73,700
				14,950	(15,250)

Since by discounting cash flows at 20% we are getting value of Project X is positive and value of Project Y is negative. Therefore, let us discount cash flows of Project X using 25% discounting rate and Project Y using discount rate of 15%.

Year	Cash Inflows Project X (₹)	Present Value Factor @ 25%	PV of Project X (₹)	Cash Inflows Project Y (₹)	Present Value Factor @ 15%	PV of Project Y (₹)
0	(2,50,000)	1.000	(2,50,000)	(3,00,000)	1.000	(3,00,000)
1	2,00,000	0.800	1,60,000	50,000	0.870	43,500
2	1,00,000	0.640	64,000	1,00,000	0.756	75,600
3	50,000	0.512	25,600	3,00,000	0.658	1,97,400
			(400)			16,500

The internal rate can be obtained by interpolation:

$$IRR_X = 20\% + \frac{14,950}{14,950 - (400)} \times (25\% - 20\%)$$

$$= 20\% + \left( \frac{14,950}{15,350} \times 5\% \right) = 24.87\%$$

$$IRR_B = 15\% + \frac{16,500}{16,500 - (15,250)} \times (20\% - 15\%)$$

$$= 15\% + \left( \frac{16,500}{31,750} \times 5\% \right) = 17.60\%$$

#### Overall Position

	Project A	Project B
NPV @ 10%	51,950	53,350
IRR	24.87%	17.60%

Thus there is contradiction in ranking by two methods.

**Scenario 3 – Disparity in life of Proposals (Unequal Lives)**

Conflict in ranking may also arise if we are comparing two projects (especially mutually exclusive) having unequal lives.

**Illustration 12:** Suppose MVA Ltd. is considering two Project A and Project B for investment. The cash flows associated with these projects are as follows:

Year	Project A	Project B
0	(5,00,000)	(5,00,000)
1	7,50,000	2,00,000
2		2,00,000
3		7,00,000

Assuming Cost of Capital equal to 12%, which project should be accepted as per NPV Method and IRR Method?

**Solution**

Net Present Value of Projects

Year	Cash Inflows Project A (₹)	Cash Inflows Project B (₹)	Present Value Factor @ 12%	PV of Project A (₹)	PV of Project B (₹)
0	(5,00,000)	(5,00,000)	1.000	(5,00,000)	(5,00,000)
1	7,50,000	2,00,000	0.893	6,69,750	1,78,600
2		2,00,000	0.797		1,59,400
3		7,00,000	0.712		4,98,400
				1,69,750	3,36,400

Internal Rate of Returns of projects

Let us discount cash flows using 50% discounting rate.

Year	Cash Inflows Project A (₹)	Cash Inflows Project B (₹)	Present Value Factor @ 50%	PV of Project A (₹)	PV of Project B (₹)
0	(5,00,000)	(5,00,000)	1.000	(5,00,000)	(5,00,000)
1	7,50,000	2,00,000	0.667	5,00,025	1,33,400
2		2,00,000	0.444		88,800
3		7,00,000	0.296		2,07,200
				25	(70,600)

Since, IRR of project A shall be 50% as NPV is almost near to zero. Further, by discounting cash flows at 50% we are getting NPV of Project B negative, let us discount cash flows of Project B using 15% discounting rate.

Year	Cash Inflows Project B (₹)	Present Value Factor @ 15%	PV of Project B (₹)
0	(5,00,000)	1.000	(5,00,000)
1	2,00,000	0.870	1,74,000
2	2,00,000	0.756	1,51,200
3	7,00,000	0.658	4,60,600
			2,85,800

The internal rate can be obtained by interpolation:

$$\begin{aligned}
 \text{IRR}_B &= 15\% + \frac{2,85,800}{2,85,800 - (70,600)} \times (50\% - 15\%) \\
 &= 15\% + \left( \frac{2,85,800}{3,56,400} \times 35\% \right) = 43.07\%
 \end{aligned}$$

#### Overall Position

	Project A	Project B
NPV @ 10%	1,69,750	3,36,400
IRR	50.00%	43.07%

Thus there is contradiction in ranking by two methods.

**6.7.9 Discounted Payback Period Method:** Some accountants prefer to calculate payback period after discounting the cash flow by a predetermined rate and the payback period so calculated is called, '*Discounted payback period*'. One of the most popular economic criteria for evaluating capital projects also is the payback period. Payback period is the time required for cumulative cash inflows to recover the cash outflows of the project.

This is considered to be superior than simple payback period method because it takes into account time value of money.

For example, a ₹ 30,000 cash outlay for a project with annual cash inflows of ₹ 6,000 would have a payback of 5 years (₹ 30,000 / ₹ 6,000).

The problem with the Payback Period is that it ignores the time value of money. In order to correct this, we can use discounted cash flows in calculating the payback period. Referring back to our example, if we discount the cash inflows at 15% required rate of return we have:

Year	Cash Flow	PVF@15%	PV	Cumulative PV
1	6,000	0.870	5,220	5,220
2	6,000	0.756	4,536	9,756
3	6,000	0.658	3,948	13,704

4	6,000	0.572	3,432	17,136
5	6,000	0.497	2,982	20,118
6	6,000	0.432	2,592	22,710
7	6,000	0.376	2,256	24,966
8	6,000	0.327	1,962	26,928
9	6,000	0.284	1,704	28,632
10	6,000	0.247	1,482	30,114

←

The cumulative total of discounted cash flows after ten years is ₹30,114. Therefore, our discounted payback is approximately 10 years as opposed to 5 years under simple payback. It should be noted that as the required rate of return increases, the distortion between simple payback and discounted payback grows. Discounted Payback is more appropriate way of measuring the payback period since it considers the time value of money.

## 6.8 Special Cases

**6.8.1 Capital Budgeting under Capital Rationing:** As discussed earlier, if project has positive NPV it should be accepted with an objective of maximisation of wealth of shareholder. However, there may be a situation due to resource (capital) constraints (rationing) a firm may have to select some projects among various projects, all having positive NPVs. Broadly two scenarios may influence the method of evaluation to be adopted.

(i) *If projects are independent of each other and are divisible in nature:* In such situation NPV Rule should be modified and accordingly projects should be ranked on the basis of 'NPV per Rupee of Capital' method.

(ii) *If projects are not divisible:* In such situation projects shall be ranked on the basis of absolute NPV and should be mixed up to the point available resources are exhausted.

**Illustration 13:** *Shiva Limited is planning its capital investment programme for next year. It has five projects all of which give a positive NPV at the company cut-off rate of 15 percent, the investment outflows and present values being as follows:*

Project	Investment	NPV @ 15%
	₹'000	₹'000
A	(50)	15.4
B	(40)	18.7
C	(25)	10.1
D	(30)	11.2
E	(35)	19.3

*The company is limited to a capital spending of ₹ 1,20,000.*

You are required to optimise the returns from a package of projects within the capital spending limit. The projects are independent of each other and are divisible (i.e., part-project is possible).

### Solution

#### Computation of NPVs per Re. 1 of Investment and Ranking of the Projects

Project	Investment	NPV @ 15%	NPV per ₹1	Ranking
	₹'000	₹'000	invested	
A	(50)	15.4	0.31	5
B	(40)	18.7	0.47	2
C	(25)	10.1	0.40	3
D	(30)	11.2	0.37	4
E	(35)	19.3	0.55	1

#### Building up of a Programme of Projects based on their Rankings

Project	Investment	NPV @ 15%	
	₹'000	₹'000	
E	(35)	19.3	
B	(40)	18.7	
C	(25)	10.1	
D	(20)	7.5	(2/3 of project total)
	120	55.6	

Thus Project A should be rejected and only two-third of Project D be undertaken. If the projects are not divisible then other combinations can be examined as:

	Investment	NPV @ 15%
	₹'000	₹'000
E + B + C	100	48.1
E + B + D	105	49.2

In this case E + B + D would be preferable as it provides a higher NPV despite D ranking lower than C.

**6.8.2 Projects with unequal lives:** Sometimes firm may be faced with any of the following problems:

- Retaining an old asset or replace it with new one.
- Choosing one proposal among two proposal (Mutually Exclusive).



Although, while evaluating the proposals above scenarios do not pose any special problems if they have same life period. But problem arises in case projects have unequal lives. In such situations we can deal with the problem by following any of the following method:

- (i) Replacement Chain Method
- (ii) Equivalent Annualized Criterion

These two methods can be understood with the help of following illustration.

**Illustration 14:** *R plc is considering to modernize its production facilities and it has two proposals under consideration. The expected cash flows associated with these project and their NPV as per discounting rate of 12% and IRR is as follows:*

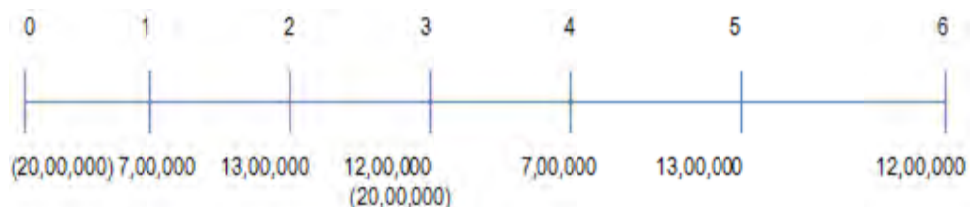
Year	Cash Flow	
	Project A (£)	Project B (£)
0	(40,00,000)	(20,00,000)
1	8,00,000	7,00,000
2	14,00,000	13,00,000
3	13,00,000	12,00,000
4	12,00,000	
5	11,00,000	
6	10,00,000	
NPV @12%	£6,49,094	£5,15,488
IRR	17.47%	25.20%

Which project should R plc accept?

#### Solution

Although from NPV point of view Project A appears to be better but from IRR point of view Project B appears to be better. Since, both projects have unequal lives selection on the basis of these two methods shall not be proper. In such situation we shall use any of the following method:

(i) *Replacement Chain (Common Life) Method:* Since the life of the Project A is 6 years and Project B is 3 years to equalize lives we can have second opportunity of investing in project B after one time investing. The position of cash flows in such situation shall be as follows:



NPV of extended life of 6 years of Project B shall be £ 8,82,403 and IRR of 25.20%. Accordingly, with extended life NPV of Project B it appears to be more attractive.

(ii) *Equivalent Annualized Criterion:* Method discussed above has one drawback when we have to compare two projects one has a life of 3 years and other has 5 years. In such case the above method shall require analysis of a period of 15 years i.e. common multiple of these two values. The simple solution to this problem is use of Equivalent Annualised Criterion involving following steps:

- Compute NPV using the WACC or discounting rate.
- Compute Present Value Annuity Factor (PVAF) of discounting factor used above for the period of each project.
- Divide NPV computed under step (a) by PVAF as computed under step (b) and compare the values.

Accordingly, for proposal under consideration:

	Project A	Project B
NPV @ 12%	£6,49,094	£5,15,488
PVAF @12%	4.112	2.402
Equivalent Annualized Criterion	£1,57,854	£2,14,608

Thus, Project B should be selected.

**Illustration 15:** *Alpha Company is considering the following investment projects:*

Projects	Cash Flows (₹)			
	$C_0$	$C_1$	$C_2$	$C_3$
A	-10,000	+10,000		
B	-10,000	+7,500	+7,500	
C	-10,000	+2,000	+4,000	+12,000
D	-10,000	+10,000	+3,000	+3,000

- Rank the projects according to each of the following methods: (i) Payback, (ii) ARR, (iii) IRR and (iv) NPV, assuming discount rates of 10 and 30 per cent.
- Assuming the projects are independent, which one should be accepted? If the projects are mutually exclusive, which project is the best?

**Solution**

- (a) (i) **Payback Period**

Project A :  $10,000/10,000 = 1$  year

Project B:  $10,000/7,500 = 1 \frac{1}{3}$  years.

Project C:  $2 \text{ years} + \frac{10,000 - 6,000}{12,000} = 2 \frac{1}{3}$  years

Project D: 1 year.

(ii) **ARR**

Project A:  $\frac{(10,000 - 10,000)1/2}{(10,000)1/2} = 0$

Project B:  $\frac{(15,000 - 10,000)1/2}{(10,000)1/2} = \frac{2,500}{5,000} = 50\%$

Project C:  $\frac{(18,000 - 10,000)1/3}{(10,000)1/2} = \frac{2,667}{5,000} = 53\%$

Project D:  $\frac{(16,000 - 10,000)1/3}{(10,000)1/2} = \frac{2,000}{5,000} = 40\%$

**Note:** This net cash proceed includes recovery of investment also. Therefore, net cash earnings are found by deducting initial investment.

(iii) **IRR**

Project A: The net cash proceeds in year 1 are just equal to investment. Therefore,  $r = 0\%$ .

Project B: This project produces an annuity of ₹ 7,500 for two years. Therefore, the required PVA factor is:  $10,000/7,500 = 1.33$ .

This factor is found under 32% column. Therefore,  $r = 32\%$

Project C: Since cash flows are uneven, the trial and error method will be followed. Using 20% rate of discount the NPV is + ₹1,389. At 30% rate of discount, the NPV is -₹633. The true rate of return should be less than 30%. At 27% rate of discount it is found that the NPV is -₹86 and at 26% +₹105. Through interpolation, we find  $r = 26.5\%$

Project D: In this case also by using the trial and error method, it is found that at 37.6% rate of discount NPV becomes almost zero.

Therefore,  $r = 37.6\%$ .

(iv) **NPV**

Project A:

at 10%  $-10,000 + 10,000 \times 0.909 = -910$

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at 30%  $-10,000 + 10,000 \times 0.769 = -2,310$

*Project B:*

at 10%  $-10,000 + 7,500(0.909 + 0.826) = 3,013$

at 30%  $-10,000 + 7,500(0.769 + 0.592) = +208$

*Project C:*

at 10%  $-10,000 + 2,000 \times 0.909 + 4,000 \times 0.826 + 12,000 \times 0.751 = +4,134$

at 30%  $-10,000 + 2,000 \times 0.769 + 4,000 \times 0.592 + 12,000 \times 0.455 = -633$

*Project D:*

at 10%  $-10,000 + 10,000 \times 0.909 + 3,000 \times (0.826 + 0.751) = +3,821$

at 30%  $-10,000 + 10,000 \times 0.769 + 3,000 \times (0.592 + 0.455) = +831$

*The projects are ranked as follows according to the various methods:*

Projects	Ranks				
	PBP	ARR	IRR	NPV (10%)	NPV (30%)
A	1	4	4	4	4
B	2	2	2	3	2
C	3	1	3	1	3
D	1	3	1	2	1

- (b) Payback and ARR are theoretically unsound method for choosing between the investment projects. Between the two time-adjusted (DCF) investment criteria, NPV and IRR, NPV gives consistent results. If the projects are independent (and there is no capital rationing), either IRR or NPV can be used since the same set of projects will be accepted by any of the methods. In the present case, except Project A all the three projects should be accepted if the discount rate is 10%. Only Projects B and D should be undertaken if the discount rate is 30%.

If it is assumed that the projects are mutually exclusive, then under the assumption of 30% discount rate, the choice is between B and D (A and C are unprofitable). Both criteria IRR and NPV give the same results – D is the best. Under the assumption of 10% discount rate, ranking according to IRR and NPV conflict (except for Project A). If the IRR rule is followed, Project D should be accepted. But the NPV rule tells that Project C is the best. The NPV rule generally gives consistent results in conformity with the wealth maximization principle. Therefore, Project C should be accepted following the NPV rule.

**Illustration 16:** *The expected cash flows of three projects are given below. The cost of capital is 10 per cent.*

- (a) *Calculate the payback period, net present value, internal rate of return and accounting rate of return of each project.*

(b) Show the rankings of the projects by each of the four methods.

Period	Project A (₹)	Project B (₹)	Project C (₹)
0	(5,000)	(5,000)	(5,000)
1	900	700	2,000
2	900	800	2,000
3	900	900	2,000
4	900	1,000	1,000
5	900	1,100	
6	900	1,200	
7	900	1,300	
8	900	1,400	
9	900	1,500	
10	900	1,600	

### Solution

(a) Payback Period Method

$$A = 5 + (500/900) = 5.56 \text{ years}$$

$$B = 5 + (500/1,200) = 5.42 \text{ years}$$

$$C = 2 + (1,000/2,000) = 2.5 \text{ years}$$

Net Present Value

$$NPV_A = (-5,000) + (900 \times 6.145) = (-5,000) + 5,530.5 = ₹530.5$$

NPV<sub>B</sub> is calculated as follows:

Year	Cash flow (₹)	10% discount factor	Present value (₹)
0	(5000)	1.000	(5,000)
1	700	0.909	636
2	800	0.826	661
3	900	0.751	676
4	1000	0.683	683
5	1100	0.621	683
6	1200	0.564	677
7	1300	0.513	667
8	1400	0.467	654
9	1500	0.424	636
10	1600	0.386	<u>618</u>
			<u>1591</u>

NPV<sub>C</sub> is calculated as follows:

Year	Cash flow (₹)	10% discount factor	Present value (₹)
0	(5000)	1.000	(5,000)
1	2000	0.909	1,818
2	2000	0.826	1,652
3	2000	0.751	1,502
4	1000	0.683	<u>683</u>
			<u>655</u>

*Internal Rate of Return*

NPV at 12% = (5,000) + 900 × 5.650

= (5,000) + 5085 = 85

NPV at 13% = (5,000) + 900 × 5.426

= (5,000) + 4,883.40 = -116.60

$$IRR_A = 12 + \left[ \frac{85}{85 + 116.60} \right] \times (13 - 12) = 12 + 0.42$$

IRR<sub>A</sub> = 12.42%.

IRR<sub>B</sub>

Year	Cash flow (₹)	10% discount factor	Present value (₹)	20% discount factor	Present value (₹)
0	(5,000)	1.000	(5,000)	1.000	(5,000)
1	700	0.909	636	0.833	583
2	800	0.826	661	0.694	555
3	900	0.751	676	0.579	521
4	1,000	0.683	683	0.482	482
5	1,100	0.621	683	0.402	442
6	1,200	0.564	677	0.335	402
7	1,300	0.513	667	0.279	363
8	1,400	0.467	654	0.233	326
9	1,500	0.424	636	0.194	291
10	1,600	0.386	<u>618</u>	0.162	<u>259</u>
			<u>1,591</u>		<u>(776)</u>

Interpolating:  $IRR_B =$

$$10\% + \frac{1,591}{(1,591 + 776)} \times (20\% - 10\%) = 10\% + 6.72\% = 16.72\%$$

$IRR_C$

Year	Cash flow (₹)	15% discount factor	Present value (₹)	18% discount factor	Present value (₹)
0	(5,000)	1.000	(5,000)	1.000	(5,000)
1	2,000	0.870	1,740	0.847	1,694
2	2,000	0.756	1,512	0.718	1,436
3	2,000	0.658	1,316	0.609	1,218
4	1,000	0.572	<u>572</u>	0.516	<u>516</u>
			<u>140</u>		<u>(136)</u>

$$\text{Interpolating: } IRR_C = 15\% + \frac{140}{(140 + 136)} \times (18\% - 15\%) = 15\% + 1.52\% = 16.52\%$$

*Accounting Rate of Return*

$$ARR_A: \text{Average capital employed} = \frac{5,000}{2} = ₹ 2,500$$

$$\text{Average accounting profit} = \frac{(9,000 - 5,000)}{10} = ₹ 400$$

$$ARR_A = \frac{(400 \times 100)}{2,500} = 16 \text{ per cent}$$

$$ARR_B: \text{Average accounting profit} = \frac{(11,500 - 5,000)}{10} = ₹ 650$$

$$ARR_B = \frac{(650 \times 100)}{2,500} = 26 \text{ per cent}$$

$$ARR_C: \text{Average accounting profit} = \frac{(7,000 - 5,000)}{4} = ₹ 500$$

$$ARR_C = \frac{(500 \times 100)}{2,500} = 20 \text{ per cent}$$

## (b) Summary of Results

Project	A	B	C
Payback (years)	5.5	5.4	2.5
ARR (%)	16	26	20
IRR (%)	12.42	16.72	16.52
NPV (₹)	530.50	1,591	655

## Comparison of Rankings

Method	Payback	ARR	IRR	NPV
1	C	B	B	B
2	B	C	C	C
3	A	A	A	A

**Illustration 17:** Lockwood Limited wants to replace its old machine with a new automatic machine. Two models A and B are available at the same cost of ₹ 5 lakhs each. Salvage value of the old machine is ₹ 1 lakh. The utilities of the existing machine can be used if the company purchases A. Additional cost of utilities to be purchased in that case are ₹ 1 lakh. If the company purchases B then all the existing utilities will have to be replaced with new utilities costing ₹ 2 lakhs. The salvage value of the old utilities will be ₹ 0.20 lakhs. The earnings after taxation are expected to be:

Year	(cash in-flows of)		
	A ₹	B ₹	P.V. Factor @ 15%
1	1,00,000	2,00,000	0.87
2	1,50,000	2,10,000	0.76
3	1,80,000	1,80,000	0.66
4	2,00,000	1,70,000	0.57
5	1,70,000	40,000	0.50
Salvage Value at the end of Year 5	50,000	60,000	

The targeted return on capital is 15%. You are required to (i) Compute, for the two machines separately, net present value, discounted payback period and desirability factor and (ii) Advice which of the machines is to be selected ?

## Solution

## (i) Expenditure at year zero

(₹ in lakhs)

Particulars	A	B
Cost of Machine	5.00	5.00



Cost of Utilities	1.00	2.00
Salvage of Old Machine	(1.00)	(1.00)
Salvage of Old Utilities	–	(0.20)
Total Expenditure (Net)	5.00	5.80

## (ii) Discounted Value of Cash inflows

(₹ in lakhs)

Year	NPV Factor @ 15%	Machine A		Machine B	
		Cash inflows	Discounted value of inflows	Cash Flows	Discounted value of inflows
0	1.00	(5.00)	(5.00)	(5.80)	(5.80)
1	0.87	1.00	0.87	2.00	1.74
2	0.76	1.50	1.14	2.10	1.60
3	0.66	1.80	1.19	1.80	1.19
4	0.57	2.00	1.14	1.70	0.97
5	0.50	1.70	0.85	0.40	0.20
Salvage	0.50	0.50	0.25	0.60	0.30
Net Present Value			5.44 (+)0.44		6.00 (+)0.20

Since the Net present Value of both the machines is positive both are acceptable.

## (iii) Discounted Pay-back Period

(₹ in lakhs)

Year	Machine A		Machine B	
	Discounted cash inflows	Cumulative Discounted cash inflows	Discounted cash inflows	Cumulative Discounted cash inflows
1	0.87	0.87	1.74	1.74
2	1.14	2.01	1.60	3.34
3	1.19	3.20	1.19	4.53
4	1.14	4.34	0.97	5.50
5	1.10*	5.44	0.50	6.00

\* Includes salvage value

Discounted Payback Period (For A and B):

$$4 \text{ years} + \left( \frac{0.66}{1.10} \right) \times 1 = 4.6 \text{ years} \quad 4 \text{ years} + \left( \frac{0.30}{0.50} \right) \times 1 = 4.6 \text{ years}$$

$$\text{Profitability Index: } \frac{\text{Sum of present value of net cash inflow}}{\text{Initial cash outlay}}$$

$$\frac{\text{₹ 5.44 lakhs}}{\text{₹ 5.00 lakhs}} = 1.088 \text{ (A)} \quad \frac{\text{₹ 6.00 lakhs}}{\text{₹ 5.80 lakhs}} = 1.034 \text{ (B)}$$

- (iv) Since the absolute surplus in the case of A is more than B and also the desirability factor, it is better to choose A.

The discounted payback period in both the cases is same, also the net present value is positive in both the cases but the desirability factor (profitability index) is higher in the case of Machine A, it is therefore better to choose Machine A.

**Illustration 18:** Hindlever Company is considering a new product line to supplement its range line. It is anticipated that the new product line will involve cash investments of ₹ 7,00,000 at time 0 and ₹ 10,00,000 in year 1. After-tax cash inflows of ₹ 2,50,000 are expected in year 2, ₹ 3,00,000 in year 3, ₹ 3,50,000 in year 4 and ₹ 4,00,000 each year thereafter through year 10. Although the product line might be viable after year 10, the company prefers to be conservative and end all calculations at that time.

- (a) If the required rate of return is 15 per cent, what is the net present value of the project? Is it acceptable?
- (b) What would be the case if the required rate of return were 10 per cent?
- (c) What is its internal rate of return?
- (d) What is the project's payback period?

#### Solution

(a)

Year	Cash flow	Discount Factor (15%)	Present value
	₹		₹
0	(7,00,000)	1.000	(7,00,000)
1	(10,00,000)	0.870	(8,70,000)
2	2,50,000	0.756	1,89,000
3	3,00,000	0.658	1,97,400
4	3,50,000	0.572	2,00,200
5–10	4,00,000	2.163	<u>8,65,200</u>
Net Present Value			<u>= (1,18,200)</u>

As the net present value is negative, the project is unacceptable.

(b) Similarly, NPV at 10% discount rate can be computed as follows:

Year	Cash flow	Discount Factor (10%)	Present value
	₹		₹
0	(7,00,000)	1.000	(7,00,000)
1	(10,00,000)	0.909	(9,09,000)
2	2,50,000	0.826	2,06,500
3	3,00,000	0.751	2,25,300
4	3,50,000	0.683	2,39,050
5–10	4,00,000	2.974	11,89,600
Net Present Value			= <u>2,51,450</u>

Since NPV = ₹2,51,849 i.e. positive, hence the project would be acceptable.

$$(c) \text{ IRR} = 10\% + \frac{2,51,450}{3,69,650} \times 5$$

$$= 10\% + 3.4012$$

$$\text{IRR} = 13.40\%$$

(d) Payback Period = 6 years:

$$-\text{₹ } 7,00,000 - \text{₹ } 10,00,000 + \text{₹ } 2,50,000 + \text{₹ } 3,00,000 + \text{₹ } 3,50,000 + \text{₹ } 4,00,000 + \text{₹ } 4,00,000 = 0$$

**Illustration 19:** *Elite Cooker Company is evaluating three investment situations: (1) produce a new line of aluminum skillets, (2) expand its existing cooker line to include several new sizes, and (3) develop a new, higher-quality line of cookers. If only the project in question is undertaken, the expected present values and the amounts of investment required are:*

Project	Investment required	Present value of Future Cash-Flows
	₹	₹
1	2,00,000	2,90,000
2	1,15,000	1,85,000
3	2,70,000	4,00,000

*If projects 1 and 2 are jointly undertaken, there will be no economies; the investments required and present values will simply be the sum of the parts. With projects 1 and 3, economies are possible in investment because one of the machines acquired can be used in both production processes. The total investment required for projects 1 and 3 combined is ₹ 4,40,000. If projects 2 and 3 are undertaken, there are economies to be achieved in marketing and producing the products but not in investment. The expected present value of future cash flows for projects 2 and 3 is ₹ 6,20,000. If all three projects are undertaken simultaneously, the economies noted will still hold. However, a ₹ 1,25,000 extension on the plant will be*

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necessary, as space is not available for all three projects. Which project or projects should be chosen?

### Solution

Project	Investment Required	Present value of Future Cash Flows	Net Present value
	₹	₹	₹
1	2,00,000	2,90,000	90,000
2	1,15,000	1,85,000	70,000
3	2,70,000	4,00,000	1,30,000
1 and 2	3,15,000	4,75,000	1,60,000
1 and 3	4,40,000	6,90,000	2,50,000
2 and 3	3,85,000	6,20,000	2,35,000
1, 2 and 3	6,80,000*	9,10,000	2,30,000

\*₹2,00,000 + ₹1,15,000 + ₹2,70,000 + ₹1,25,000 – [(₹2,00,000 + ₹2,70,000) - ₹4,40,000]

*Advise:* Projects 1 and 3 should be chosen, as they provide the highest net present value.

**Illustration 20:** Cello Limited is considering buying a new machine which would have a useful economic life of five years, a cost of ₹ 1,25,000 and a scrap value of ₹ 30,000, with 80 per cent of the cost being payable at the start of the project and 20 per cent at the end of the first year. The machine would produce 50,000 units per annum of a new project with an estimated selling price of ₹ 3 per unit. Direct costs would be ₹ 1.75 per unit and annual fixed costs, including depreciation calculated on a straight-line basis, would be ₹ 40,000 per annum.

In the first year and the second year, special sales promotion expenditure, not included in the above costs, would be incurred, amounting to ₹ 10,000 and ₹ 15,000 respectively.

Evaluate the project using the NPV method of investment appraisal, assuming the company's cost of capital to be 10 percent.

### Solution

#### Calculation of Net Cash flows

Contribution =  $(3.00 - 1.75) \times 50,000 = ₹62,500$

Fixed costs =  $40,000 - [(1,25,000 - 30,000)/5] = ₹21,000$

Year	Capital (₹)	Contribution (₹)	Fixed costs (₹)	Adverts (₹)	Net cash flow (₹)
0	(1,00,000)				(1,00,000)
1	(25,000)	62,500	(21,000)	(10,000)	6,500
2		62,500	(21,000)	(15,000)	26,500
3		62,500	(21,000)		41,500

4		62,500	(21,000)		41,500
5	30,000	62,500	(21,000)		71,500

**Calculation of Net Present Value**

Year	Net cash flow (₹)	10% discount factor	Present value (₹)
0	(1,00,000)	1.000	(1,00,000)
1	6,500	0.909	5,909
2	26,500	0.826	21,889
3	41,500	0.751	31,167
4	41,500	0.683	28,345
5	71,500	0.621	<u>44,402</u>
			<u>31,712</u>

The net present value of the project is ₹ 31,712.

**SUMMARY**

- Capital budgeting is the process of evaluating and selecting long-term investments that are in line with the goal of investor's wealth maximization.
- The capital budgeting decisions are important, crucial and critical business decisions due to substantial expenditure involved; long period for the recovery of benefits; irreversibility of decisions and the complexity involved in capital investment decisions.
- One of the most important tasks in capital budgeting is estimating future cash flows for a project. The final decision we make at the end of the capital budgeting process is no better than the accuracy of our cash-flow estimates.
- Tax payments like other payments must be properly deducted in deriving the cash flows. That is, cash flows must be defined in post-tax terms.
- There are a number of capital budgeting techniques available for appraisal of investment proposals and can be classified as traditional (non-discounted) and time-adjusted (discounted).
- The most common traditional capital budgeting techniques are Payback Period and Accounting (Book) Rate of Return.

$$\text{Payback period} = \frac{\text{Total initial capital investment}}{\text{Annual expected after-tax net cash flow}}$$

$$\text{Payback Reciprocal} = \frac{\text{Average annual cash in flow}}{\text{Initial investment}}$$

- The most common time-adjusted capital budgeting techniques are Net Present Value Technique and Internal Rate of Return Method.